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(56) Documents Cited

GB 2243533 A

GB 1565973 A

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(58) Field of Search

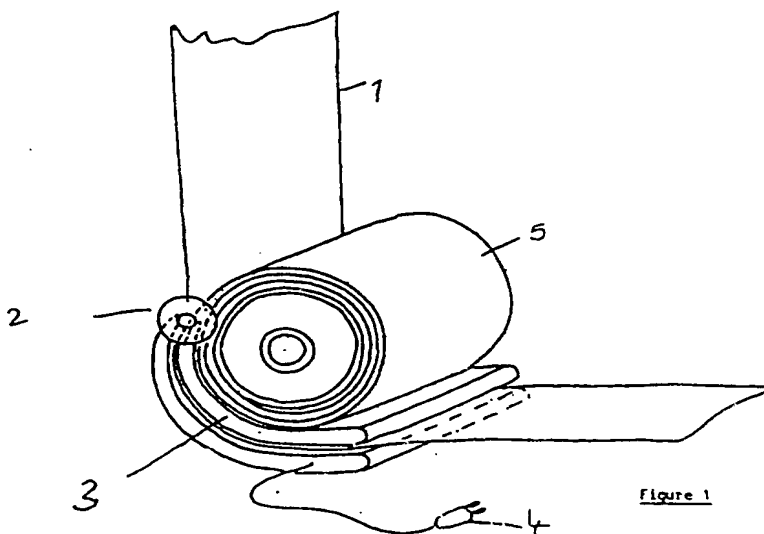
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INT CL<sup>6</sup> B60R 22/42

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(54) Electromagnetic seatbelt clamping.

(57) A retractor assembly comprises a spool 5 for seatbelt webbing 1 which passes from the spool through guide means in the form of curved brake shoes 3. The brake shoes comprise inductive material such that when current is passed through them they are attracted to each other and move to grip the webbing. Other arrangements comprise: the guide means provided remotely (Fig. 5) from the spool (e.g. on the 'B' pillar of a vehicle) and thus being able to act on a longer length of webbing; the webbing comprises inductive or conductive material woven into the fabric; the webbing spool is directly attached to a brake disc (34 Fig. 8) mounted between the poles of an electromagnet (36,38) to form an eddy current brake, a motor (40) being provided to control pay out of the belt. The motor and magnet may be combined.



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**GB 2 319 502 A**

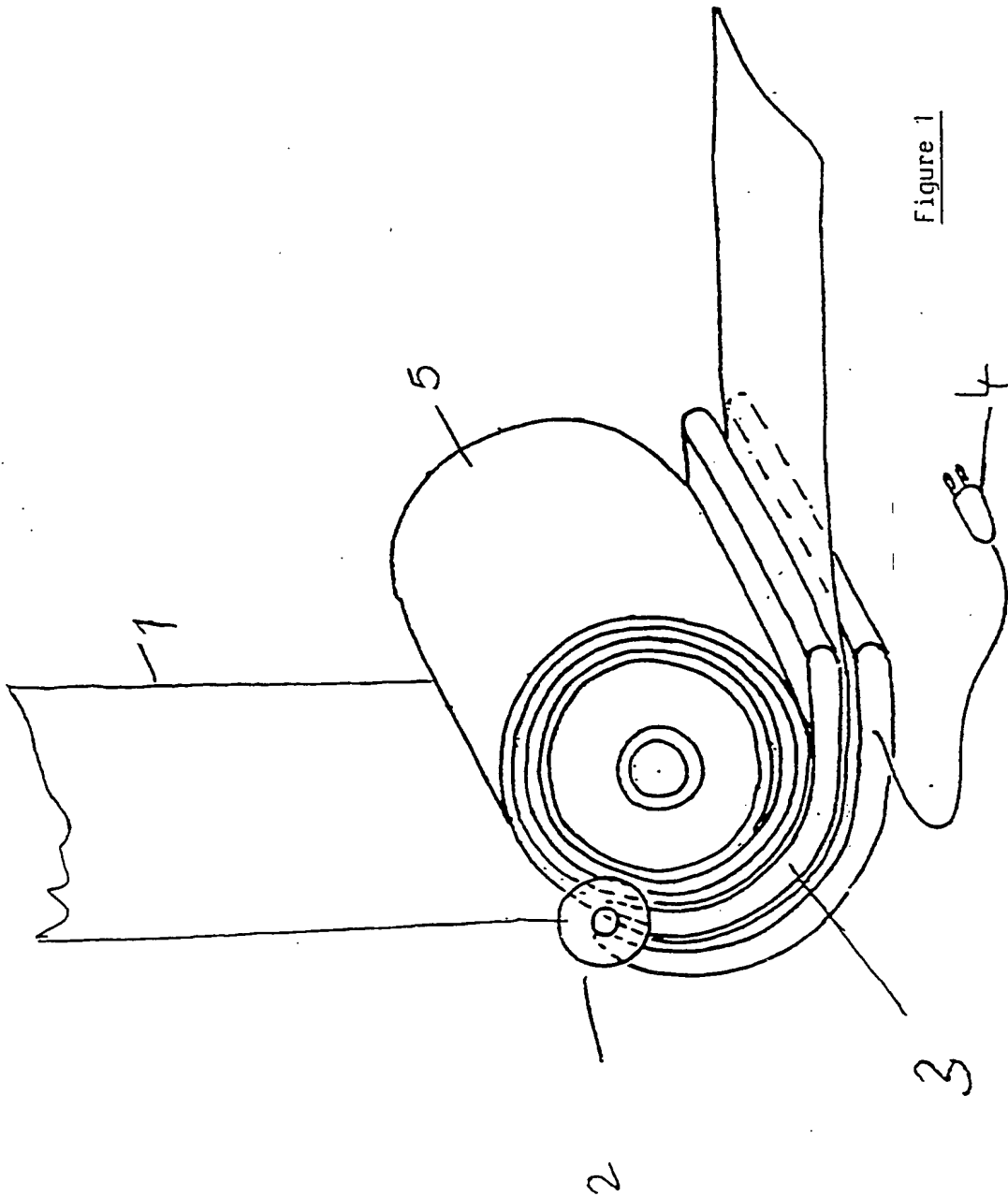


Figure 1

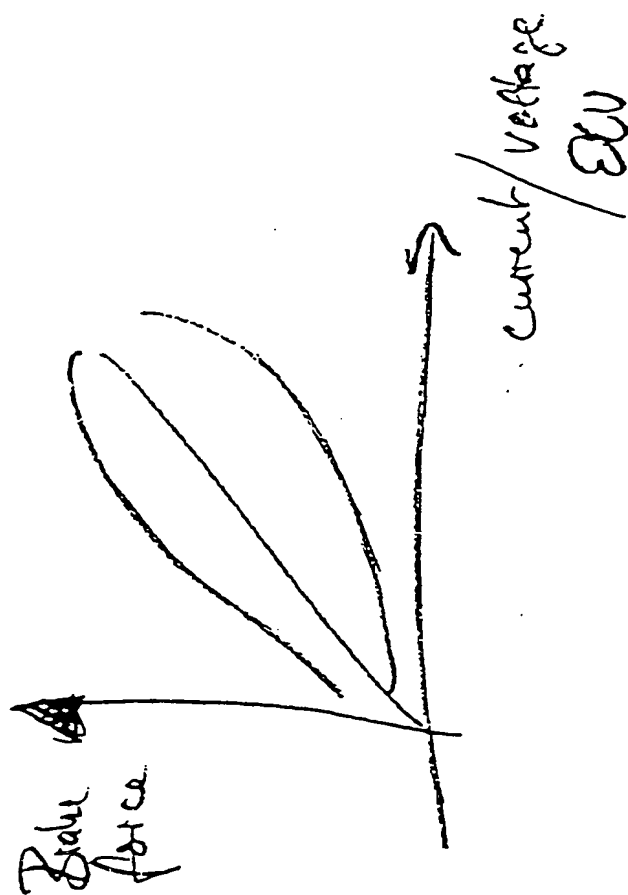


Figure 2

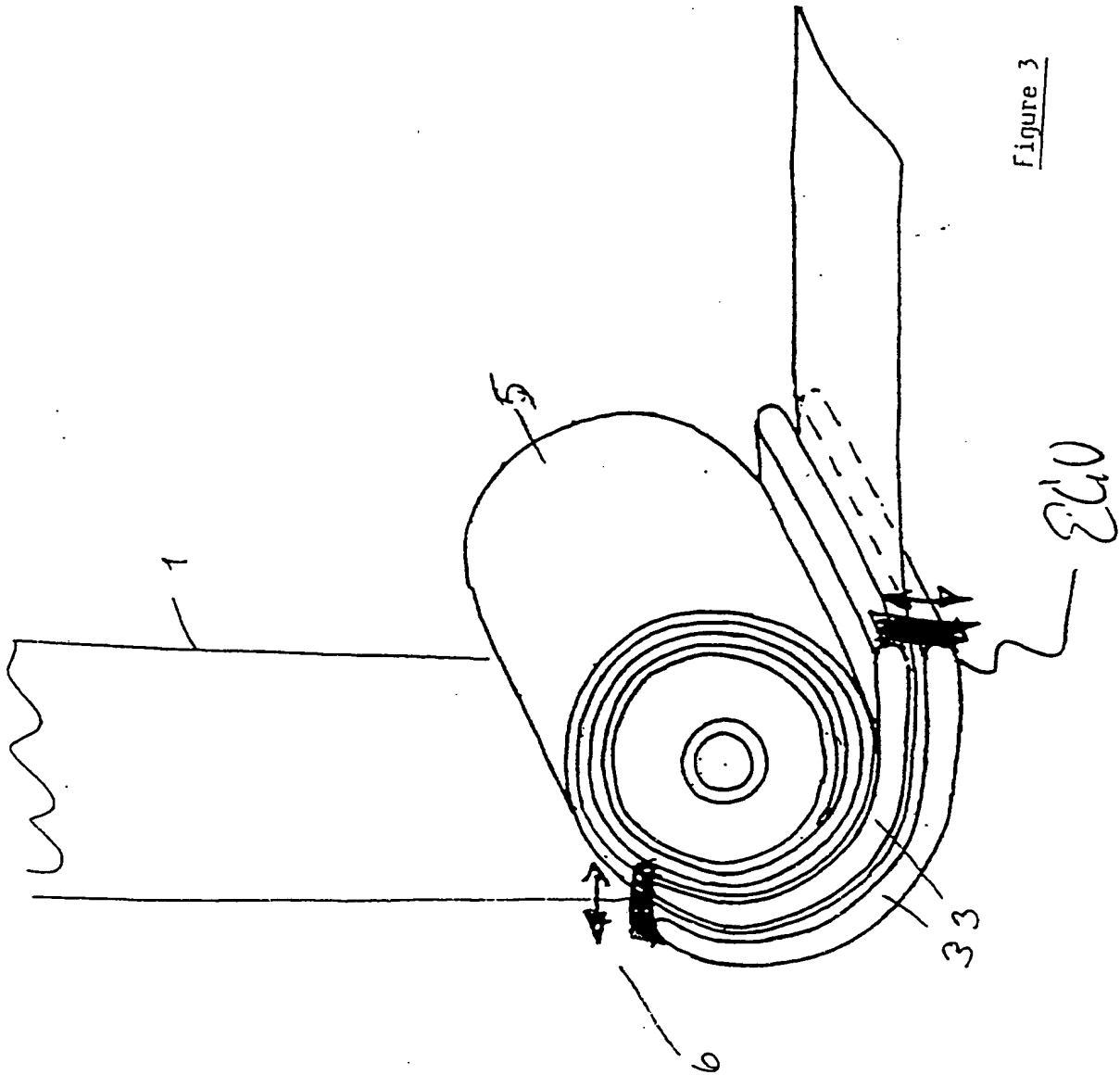


Figure 3

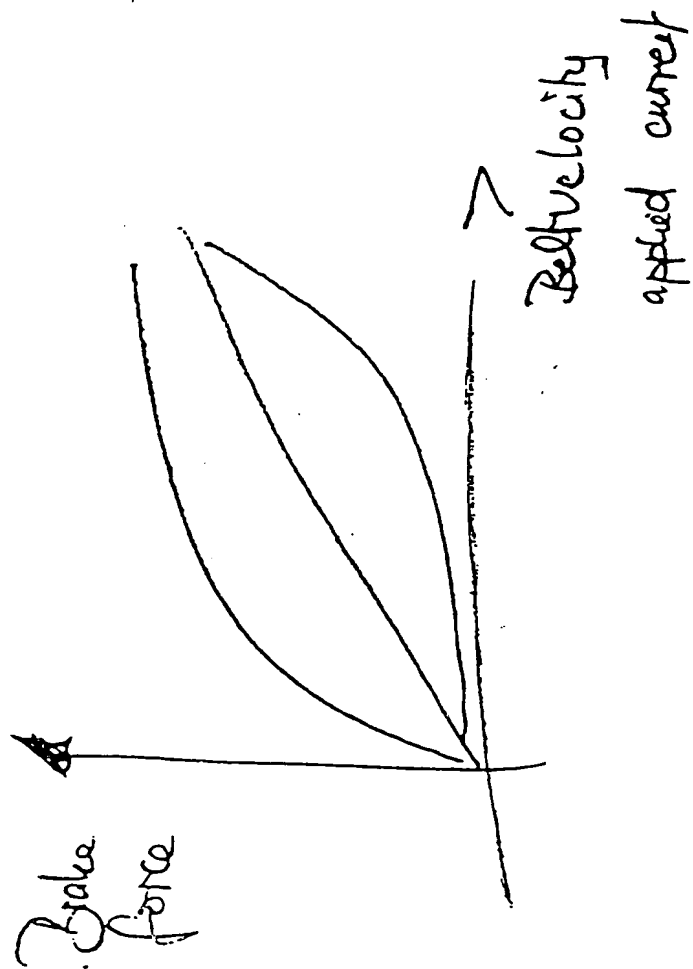


Figure 4

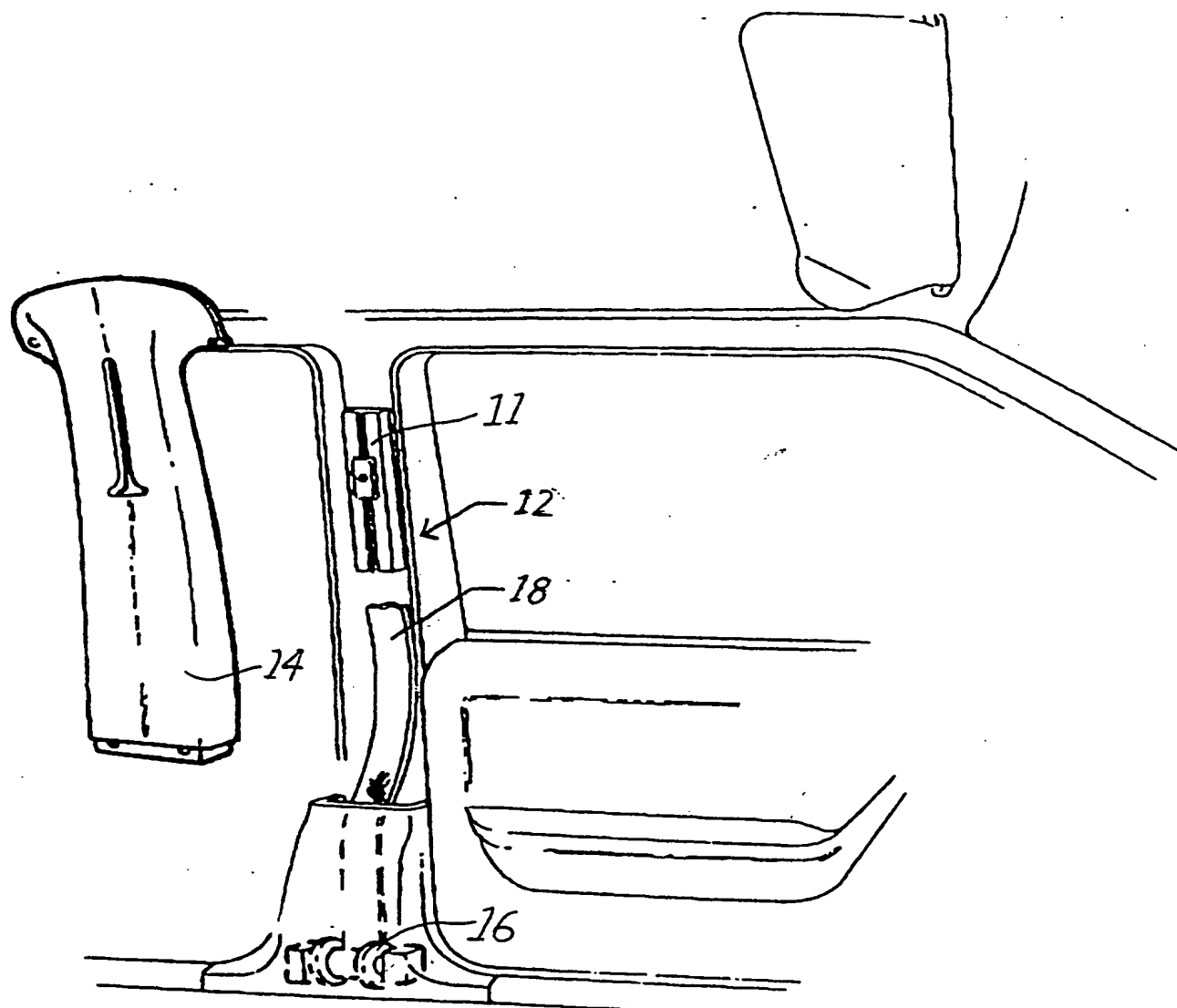


FIGURE 5

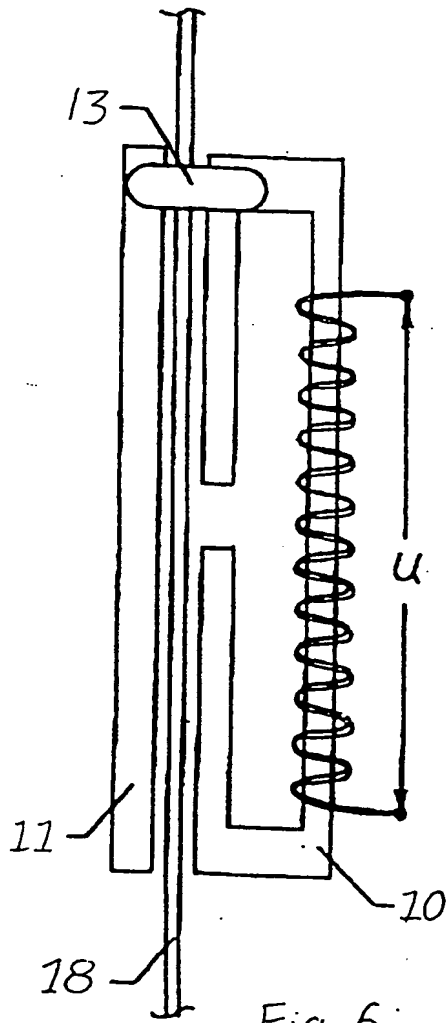


Fig. 6

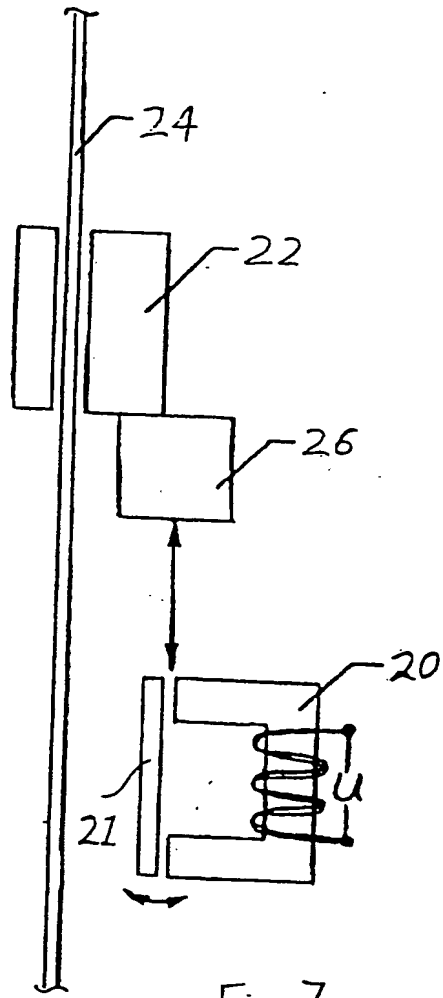


Fig. 7

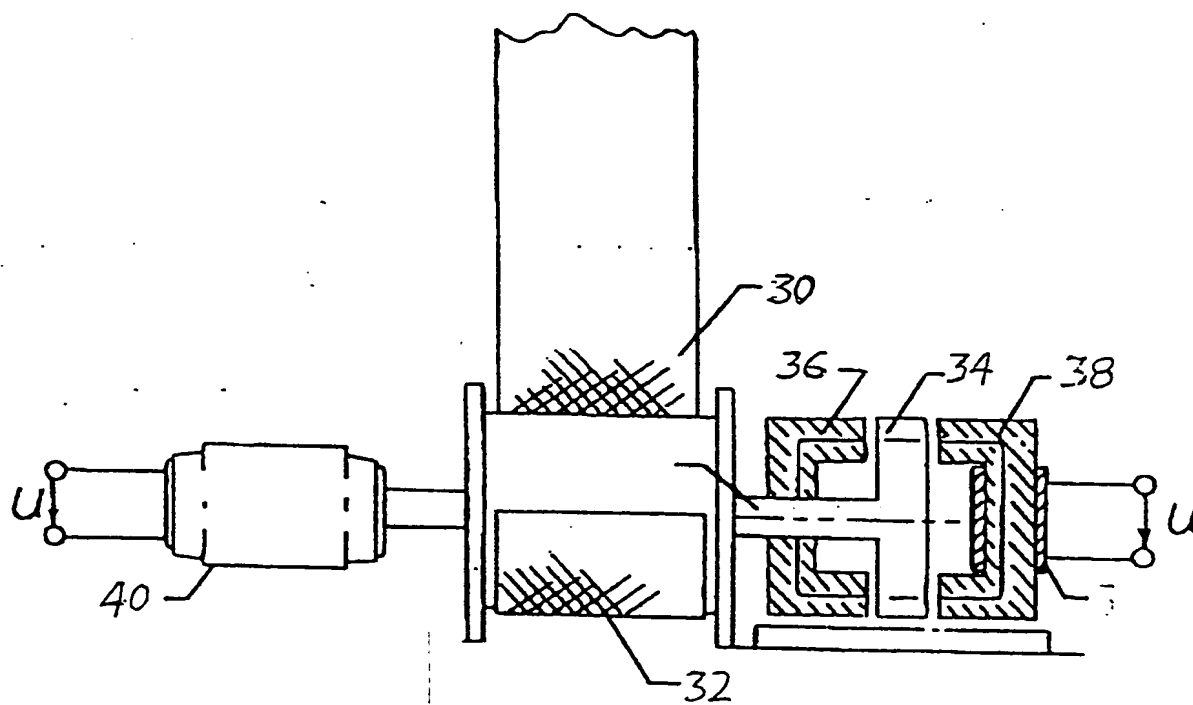


FIGURE 8



RETRACTOR

The present invention relates to a retractor for a vehicle safety restraint.

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Retractors for vehicle safety restraints typically comprise a rotatable spool on which is wound seat belt webbing. This spool is biased into a webbing wound condition by a light rewind spring so as to apply a certain  
10 minimum tension on the restrained occupant but to allow the occupant to move within limits, for example to reach the glove compartment or vehicle controls. In the event of a crash, a crash sensor typically causes the retractor to lock to prevent further pay-out of the belt and therefore to  
15 securely restrain the occupant. In modern retractor systems an additional web-locking feature is often included by which, in addition to locking the spool against rotation, the seat belt webbing is clamped against further pay-out, typically between rubber wedges (with or without facing  
20 teeth) which slide within a housing towards each other on each side of the webbing until the webbing is held fast.

There is also a requirement in modern safety restraints for Load Limiting features. In high speed vehicle impacts  
25 the safety belt itself can cause injury to the occupant and Load Limiting features are increasingly being included to reduce the possibility of seat belt induced injury.

Thus a modern safety restraint belt system requires the  
30 manufacture and tooling of a large number of complex mechanical parts in order to assemble a mechanical retractor

with a web-locking feature and a Load Limiter. In addition modern web-locking systems, tend to degrade the belt because of the physical strain put on the belt by the teeth of the web clamps in a crash situation. Thus known retractor web-  
5 lockers are not generally reusable after a crash.

It is an object of the present invention to provide a retractor with a combination of features of known retractor systems in a simpler mechanical construction.

10

According to the present invention there is provided a retractor for a vehicle safety restraint system comprising a rotatable spool to hold seat belt webbing,

a guide path for the seat belt webbing,

15 the guide path being formed by two opposing member at least one of which is movable and at least one of which comprises electro-magnetic material,

wherein means are provided to apply an electric current to the electro-magnetic material to activate the electro-  
20 magnetic material to cause the movable member to move closer to the opposing member in such a way as to reduce the width of the guide path and thus to clamp the seat belt webbing between the two members.

25 The opposing member defining the guide path may be hinged so as to move pivotally towards each other or may be mounted to move translationally towards and away from each other.

30 The electric current is preferably generated by a crash sensor and may for example be the same electrical signal

which is used to fire a pretensioner or an airbag within the same vehicle in response to a crash being detected.

According to another aspect of the present invention  
5 the seat belt webbing itself comprises inductive or conductive material, for example magnesium may be woven into the fabric of the webbing (which is traditionally predominantly nylon).

10 In this way the speed of movement of the webbing through the guide path can be made to influence the braking force applied by the two sides of the guide path and the brake force can be made to be a function of the initial velocity of the seat belt webbing as well as of the distance  
15 between the two sides of the guide path. The two side members defining the guide path in this case will preferably be joined by a double brake shoe joint so that the distance between them can be selectively adjusted for optimum performance of the retractor.

20

This distance between the member can be controlled by an electronic control unit (ECU) which may be the vehicle's central control unit which coordinates other electronic safety features, such as the airbag detonation and  
25 pretensioner firing. In this way release of the seat belt once the crash situation has abated can be controlled with optimum reusability of the retractor. The electronic control unit (ECU) will also be able to record any failures of the system together with all crash incidents and will  
30 thus have a crash memory for subsequent analysis. The degree of Load Limiting can be adapted to crash severity, to

the existence of the other safety restraint features and also could be specially adapted to the occupant, for example based on markers with the belt usage.

5       According to a further aspect of the invention there is provided a retractor for a vehicle safety restraint system comprising a rotatable spool to hold seat belt webbing, a braking member attached to the spool so as to rotate therewith, and electrically operated brake means actuable to  
10 clamp the braking member to brake the spool.

The brake means may comprise an eddy current brake, and the braking member may be a brake disc.

15       For a better understanding of the present invention and to show how the same may be carried into effect preference will now be made to the accompanying drawings in which:

Figure 1 is a schematic part cross sectional view of  
20 part of a retractor according to the present invention.

Figure 2 is a graph showing brake force against the current and/or voltage applied by the ECU for the retractor of figure 1.

25

Figure 3 is a schematic part cross sectional view of another embodiment of retractor according to the invention.

Figure 4 is a graph of brake force related to belt  
30 velocity for the retractor of figure 3.

Figure 5 is a perspective view of a retractor according to another embodiment of the invention.

Figure 6 is a schematic cross sectional view of the clamping mechanism of the retractor of Figure 5.

Figure 7 is a schematic view of an alternative clamping mechanism suitable for use in the retractor of Figure 5.

Figure 8 is a schematic cross sectional view of a retractor according to another aspect of the invention.

In figure 1 seat belt webbing 1 is wound on retractor spool 5 and passes between two curved brake shoes 3. The curved brake shoes 3 are of inductive material so that when an electrical current is passed through them a magnetic field is generated between them in an attracting sense to move them closer together to grip the webbing 1. The two inductive brake shoes 3 are connected together by a pivot at joint 2. Electrical current is applied via connection 4 from the vehicle electronic control unit (ECU).

The main braking force will be applied to the webbing close to the pivot 2 and in this area a contoured surface may be provided on the inside of the brake shoes, for example ridges or teeth.

In figure 2 the effective brake force is shown as a function of the current or voltage applied to the brake shoes by the ECU and it can be seen that there is an almost direct proportionality, so that the higher the current applied to the brake shoes, the higher the brake force

applied by the brake shoes to the webbing.

Figure 3 shows seat belt webbing 1 wound around retractor spool 5 and passing between brake shoes 3. In this embodiment the seat belt is made conductive by having magnesium woven into the fabric and the brake shoes 3 are joined by a double joint at each of their ends so that the distance between them can be modified according to the particular conditions, for example of the occupant of the vehicle or of the crash.

Figure 4 illustrates the brake force as a function of the belt velocity for the embodiment of figure 3. As can be seen the faster the belt moves the greater the brake clamping force. The brake clamping force is also of course dependent upon the distance between the brake shoes and this is controlled in turn by the electronic control unit. In this way the webbing itself act as a webbing sensor so as to activate the clamping force when the webbing is moving fast (which is typically indicative of a crash situation).

In an alternative arrangement, the guide path may be provided at a location remote from the rotatable spool. As shown in Figure 5, the opposing members 10, 11 are provided in the 'B' pillar 12 of the vehicle, behind a cover 14. The 'B' pillar is the part of the vehicle frame which is located at the rear of the passenger door. The spool 16 is located at a position near the floor of the vehicle, below the pillar 12, such that the belt 18 extends between the spool 16 and the opposing members 10, 11.

Referring to Figure 6, it can be seen that with this arrangement the opposing members 10, 11 forming the clamp may act upon a longer length of the seat belt 18, for example the entire free distance along the structure of the 'B' pillar 12. The members 10, 11 are connected by means of a mechanical joint 13.

The opposing members comprise an electromagnet 10 and a brake pad 11, and this clamping arrangement is preferably operated by a crash sensor as already described in relation to Figure 1. Alternatively, the seat belt may comprise inductive material, as already described in relation to Figure 3.

The invention is based on magnetic laws where

$$1. \quad F = \frac{H \cdot B \cdot A}{2}$$

F = Force

H  $\hat{=}$  Magnetic Field

B  $\hat{=}$  Magnetic Flux

A = Surface of Field

$$2. \quad H = \frac{I \cdot N}{l}$$

I = Current in Wire

$\mu$  = Number of windings

l = length of windings

$$3. \quad Fz = Tn \cdot \mu$$

Fz = Belt load

Tn = magnetic breakforce

$\mu$  = coefficient of friction

Figure 7 illustrates an alternative arrangement for operating the clamp. With this arrangement an electromagnet 20 and brake pad 21 are provided as before, but the force is transmitted to a mechanical brake 22 operating on the seatbelt 24 via a gearbox 26. In this way the clamping or braking force can be better controlled, to limit or block seatbelt pay-out. Also, the clamping force can be increased.

In the embodiment of Figure 8, the braking of the seatbelt webbing 30 is provided by braking the webbing spool 32 itself. A brake disc 34 extends from the axis of the spool to a position between the poles of an electrical magnet 36, 38 of an eddy current brake. Eddy currents will then be created in relation to the movement of the disc 34.

The braking force is changed by the change of the magnetic drive, and therefore by the controlled current supply. In a crash situation, current is applied to the magnet 36, 38 to brake the disc 34, thus correspondingly braking the webbing spool 32. In this way rotation of the spool may be limited or blocked. The controlled current will be in direct relation with the seatbelt force.

Figure 8 also shows an electric motor 40 which operates in normal use of the seatbelt as a load limiter to control pay-out of the belt. It also reduces looseness of the belt and provides controllable seatbelt comfort. It is possible to combine the motor 40 and eddy brake function in one electrical motor by using an alternating current system.



Such an electric motor may also be used for the purposes of seatbelt comfort and reducing looseness in the embodiment of Figure 5.

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CLAIMS

1. A retractor for a vehicle safety restraint system comprising a rotatable spool to hold seat belt webbing,  
5 a guide path for the seat belt webbing,  
the guide path being formed by two opposing members at least one of which is movable and at least one of which comprises electro-magnetic material,  
wherein means are provided to apply an electric current  
10 to the electro-magnetic material to activate the electro-magnetic material to cause the movable member to move closer to the opposing member in such a way as to reduce the width of the guide path and thus to clamp the seat belt webbing between the two members.
- 15
2. A retractor according to claim 1 wherein the opposing members defining the guide path are hinged so as to move pivotally towards each other or may be mounted to move translationally towards and away from each other.
- 20
3. A retractor according to claim 1 or 2 wherein the electric current is generated by a crash sensor.
4. A retractor according to claim 3 wherein the electric  
25 current is the same electrical signal which is used to fire a pretensioner or an airbag within the same vehicle in response to a crash being detected.
5. A retractor for a vehicle safety restraint system  
30 comprising a rotatable spool to hold seat belt webbing,  
a guide path for the seat belt webbing,

the guide path being formed by two opposing members at least one of which is movable, and at least one of which comprises electro-magnetic material;

wherein the seat belt webbing comprises inductive or  
5 conductive material, for example magnesium woven into the fabric of the webbing.

6. A retractor according to claim 5 wherein the brake  
10 force is a function of the initial velocity of the seat belt webbing as well as of the distance between the two sides of the guide path.

7. A retractor according to claim 6 wherein the two  
15 opposing members defining the guide path are joined by a double brake shoe joint so that the distance between them can be selectively adjusted for optimum performance of the retractor.

8. A retractor according to claim 7 wherein said distance  
20 between the members is controlled by an electronic control unit (ECU) which may be the vehicle's central control unit which coordinates other electronic safety features, such as the airbag detonation and pretensioner firing.

25 9. A retrator for a vehicle safety restraint system comprising a rotatable spool to hold seat belt webbing, a braking member attached to the spool so as to rotate therewith, and electrically operated brake means actuable to clamp the braking member to brake the spool.

30

10. A retractor according to Claim 9, wherein the brake

means is an eddy current brake, and the braking member is a brake disc.

11. A retractor substantially as hereinbefore described  
5 with reference to Figures 1 and 2, Figures 3 and 4, Figures  
5, 6 and 7, or Figure 8 of the accompanying drawings.

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# The Patent Office

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Application No: GB 9723658.2  
Claims searched: 1-4

Examiner: J.C. Barnes-Paddock  
Date of search: 20 March 1998

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): B7B (BVRN)

Int Cl (Ed.6): B60R 22/42

Other: Online: WPI

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2 243 533 A (NISSAN) See Fig. 2 and p. 10, ll. 9-18. Solenoid operated clamping means actuated alongside a preloader.	1-4
X	GB 1 565 973 (AUTOFLUG) See Fig. 2 and p. 4, ll. 81-126. Clamping caused by electromagnet.	1-3
X	GB 1 508 853 (DeBOSREDON) See Figure. Electromagnetic means acting on wedge via link.	1,2
X	GB 1 450 139 (RENAULT/PEUGEOT) See Fig. 2. Electromagnetic means acting on shoes.	1,2
X	GB 1 447 902 (RENAULT/PEUGEOT) See Fig. 4 and p. 2, ll. 5-10, 48-52. Guide means acted upon by an electromagnet to effect clamping.	1-3
X	GB 1 225 528 (ROBBINS) See Fig. 6. Electromagnetic means acting on rollers.	1-3
X	WO 89/10285 A1 (ERNST) See Figure. A wedge member comprising an electromagnetic member that causes clamping.	1-3

X Document indicating lack of novelty or inventive step  
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